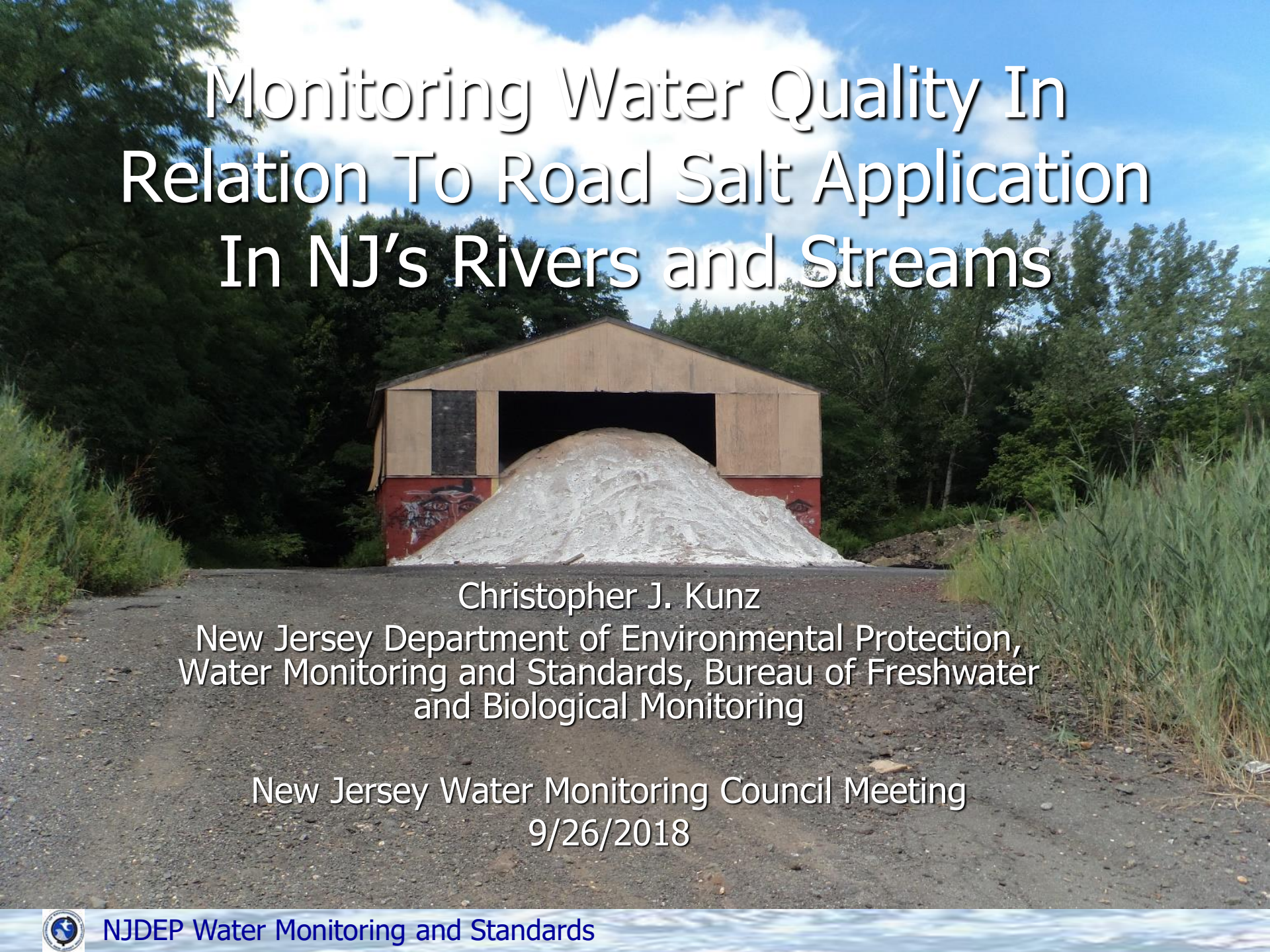
Monitoring Water Quality In Relation To Road Salt Application In NJ's Rivers and Streams



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Water Monitoring and Standards, Bureau of Freshwater and Biological Monitoring

New Jersey Water Monitoring Council Meeting
9/26/2018

Overview

- Rivers and Streams Networks
- Incorporation of Data Loggers
- Pairing Data With Weather Events
- Developing Relationships
- Filling In The Gaps
- In-Depth Watershed Evaluation
- What Now?

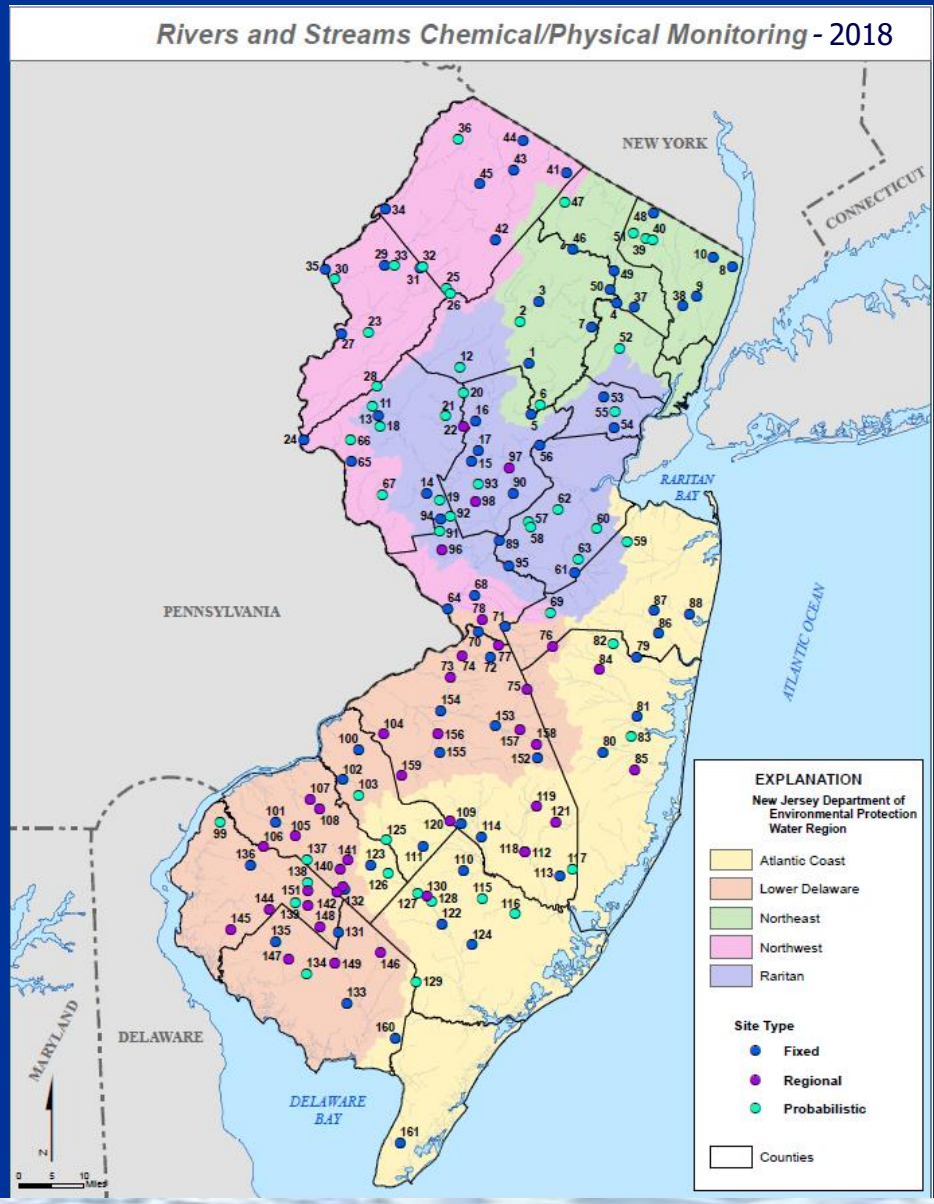
Rivers and Streams Networks

Road Salt related parameters being monitored

- Chloride
  - Criteria
    - 860 mg/L Acute Aquatic Life
    - 230 mg/L Chronic Aquatic Life
    - 250 mg/L Human Health
- TDS
  - Criteria
    - 500 mg/L or no increase in background which would interfere with the designated or existing uses, whichever is more stringent.
- Specific Conductance

Rivers and Streams Networks

- Ambient Surface Water Quality Monitoring Network (ASWQMN) (cooperative network with USGS)
  - 123 sites (73 permanent and 50 probabilistic sites)
- Regional Targeted Water Quality Network (RTWQN)
  - 25 sites/ Water Region.
  - Each region sampled 2 years.
- Historical Data available from the mid 1970s at ~1,000 sites



Rivers and Streams Networks

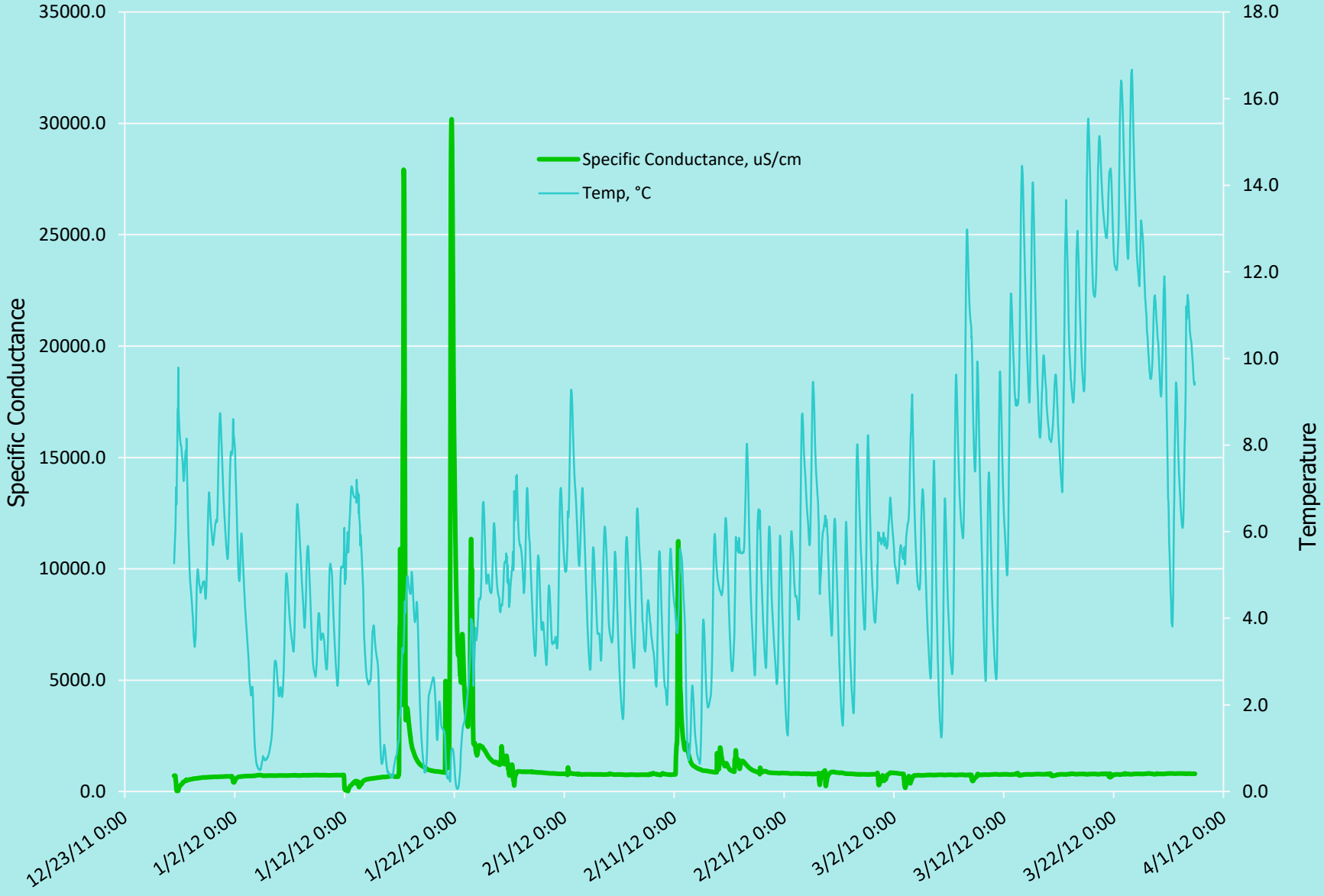
Data Availability

- National Water Quality Portal (https://www.waterqualitydata.us/) : Historic and current discrete data from BFBM.
- National Water Information System (https://waterdata.usgs.gov/nj/nwis/) : Historic and current ASWQMN data.
- Division of Water Monitoring and Standards Continuous Monitoring Program website (http://njdep.rutgers.edu/continuous/) : Continuous monitoring data.

Data Loggers

- Data loggers for specific conductance became available ~2010.
- Several units purchased and deployed in winter of 2011-2012.
- Targeted road salt monitoring project initiated in 2011.
- What is duration and severity of elevated specific conductance?

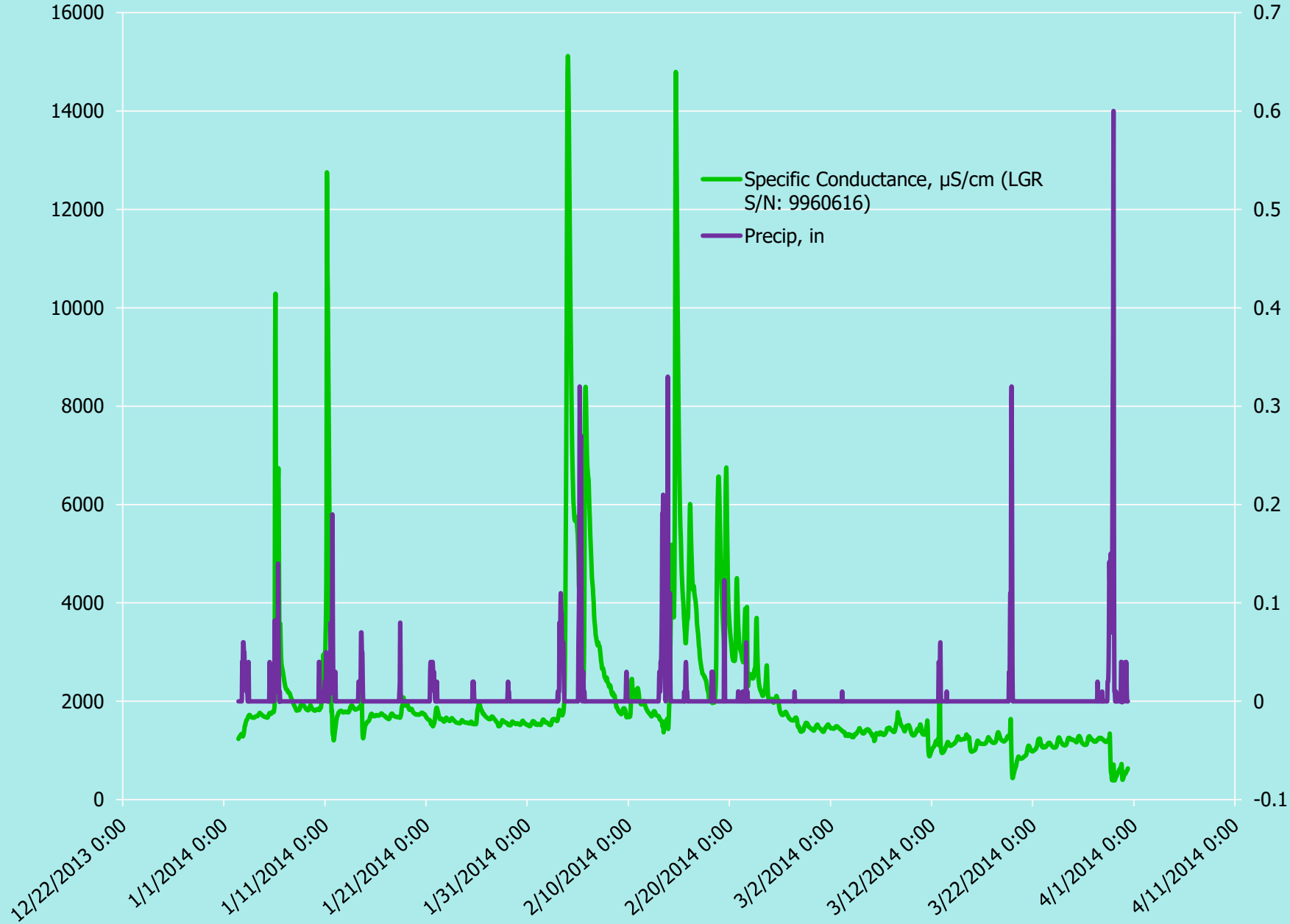
Penns Brook in Bernardsville (BFBM ID # BFBM000180)



Pairing Continuous Conductivity Data to Weather Events

- Compared continuous data to NOAA weather data from nearby weather stations.
- Used precipitation as the default surrogate for snowfall.
- Elevated specific conductance tracked well with recorded precipitation.

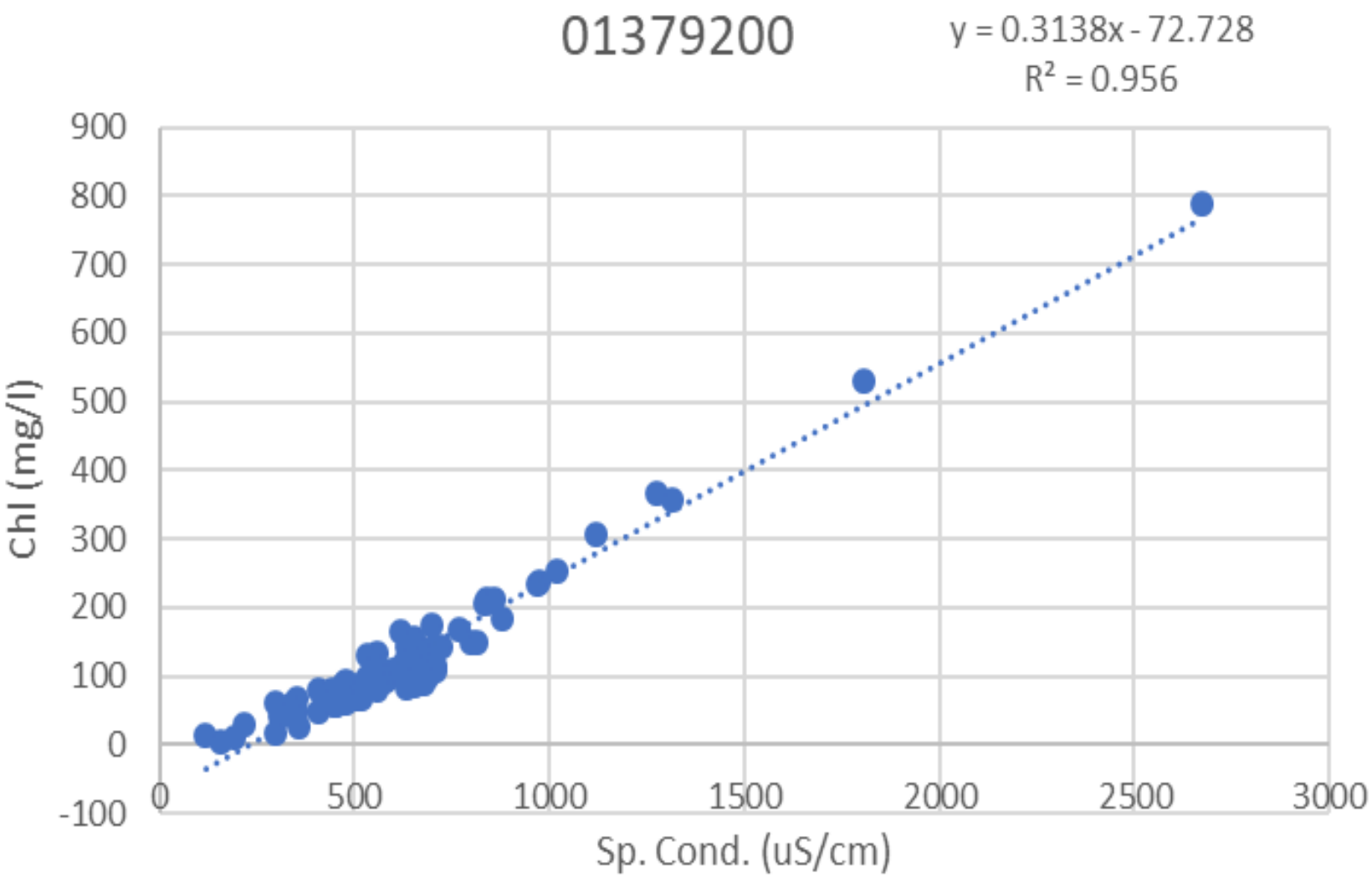
Hohokus Brook (USGS ID # 01390600)



Developing Relationships

- Relationships between specific conductance, chloride and TDS can be developed on a site-specific (potentially watershed or region specific).
- These relationships can be used to extrapolate chloride and TDS values from continuous data.

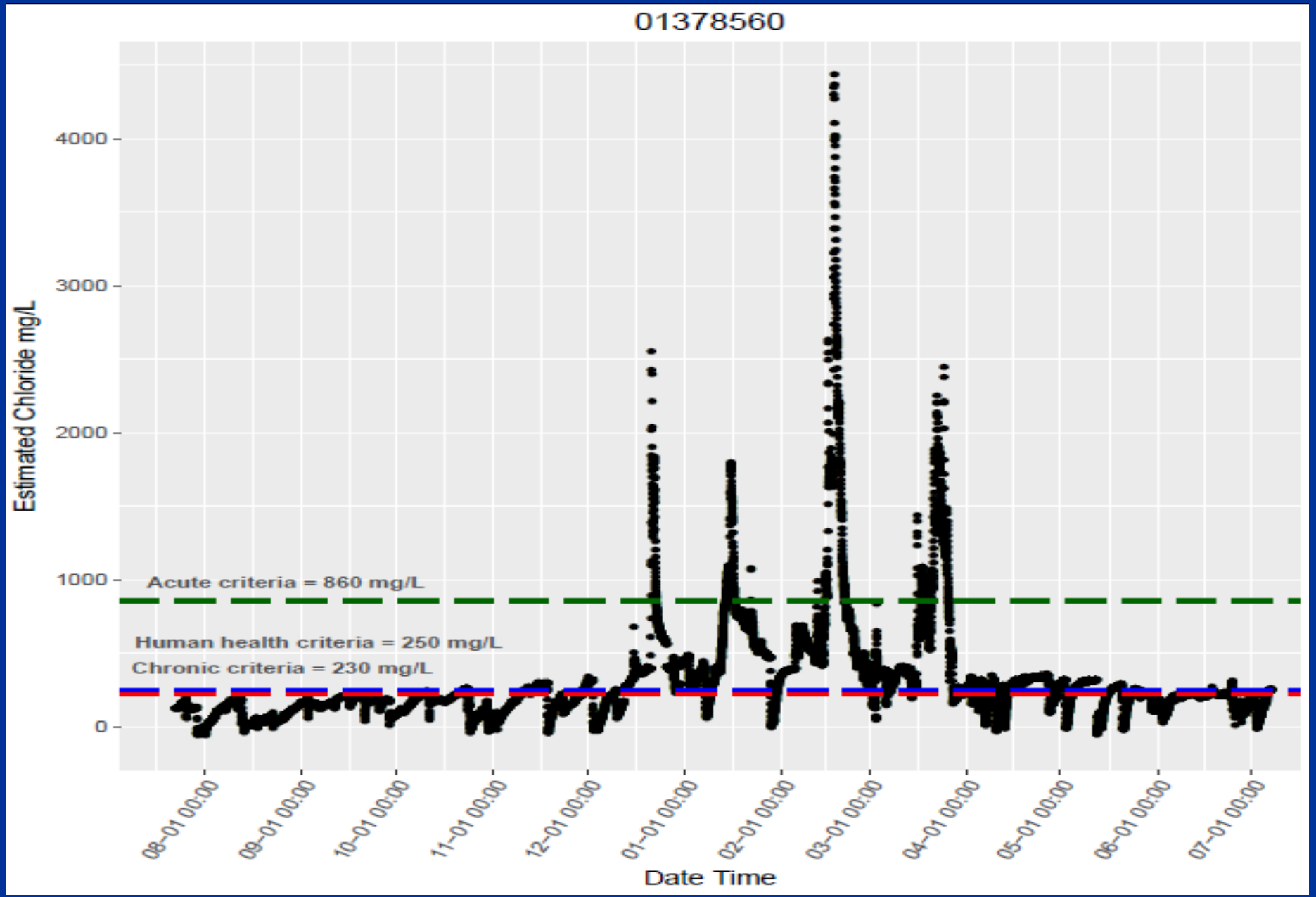
Specific Conductance vs. Chloride (Dead River)



Filling In The Gaps

- Using specific conductance relationships with chloride or TDS, we can now plot estimated chloride or TDS over the entire conductivity logger deployment.
- We can then determine the number of hours or days in which chloride or TDS was above any of the current surface water quality standards.

Estimated Chloride; July, 2016 – July 2017 (Coles Brook)



Filling In The Gaps

- Coles Brook (USGS ID # 01378560) was above the acute aquatic life criterion for chloride (860 mg/L) 412.5 hours (~17 days) between July of 2016 and July of 2017.
- It was above the human health criterion (250 mg/L) for 3,282 hours (~137 days) and above chronic aquatic life criterion for 3,698 hours (~154 days).

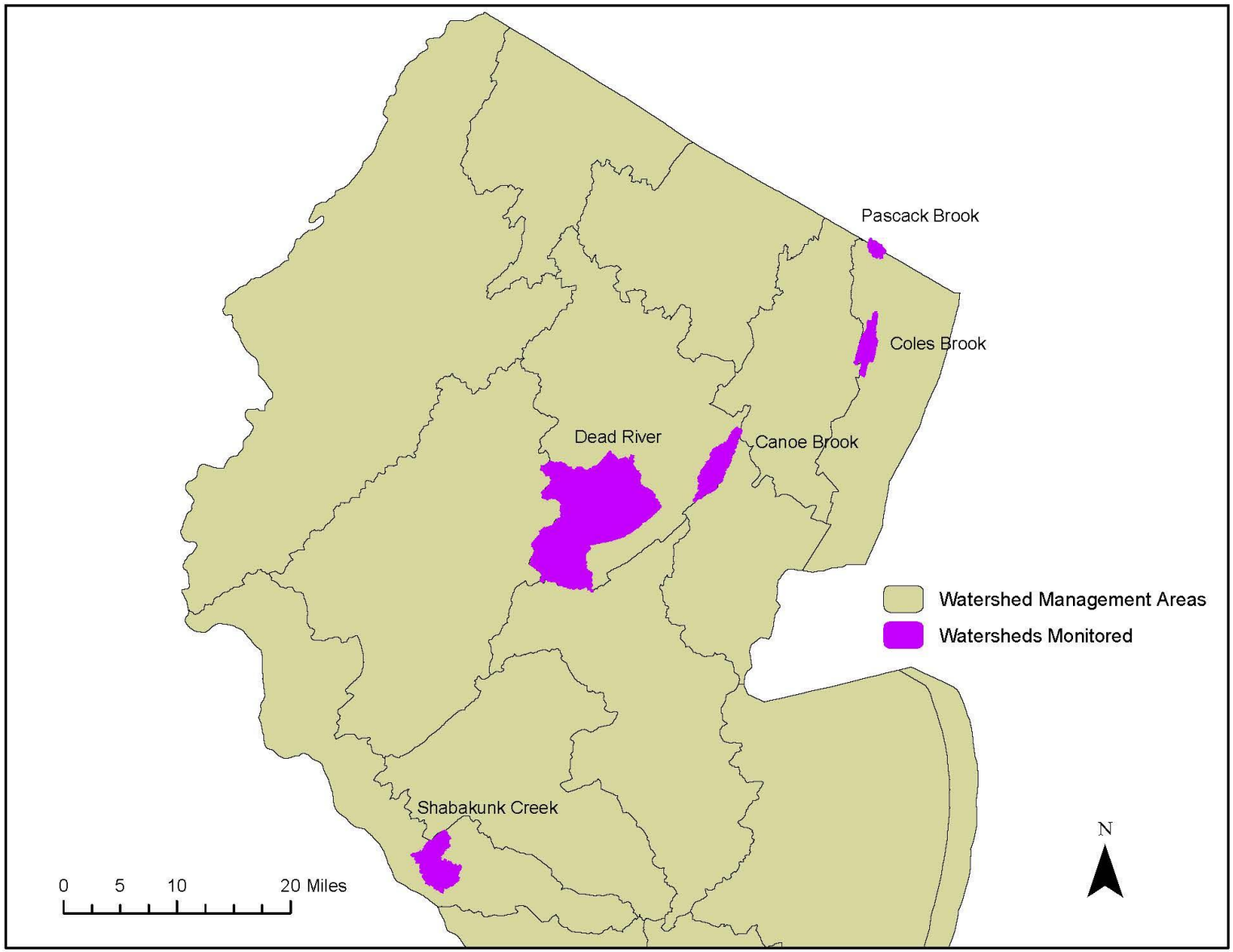
In-Depth Watershed Evaluation

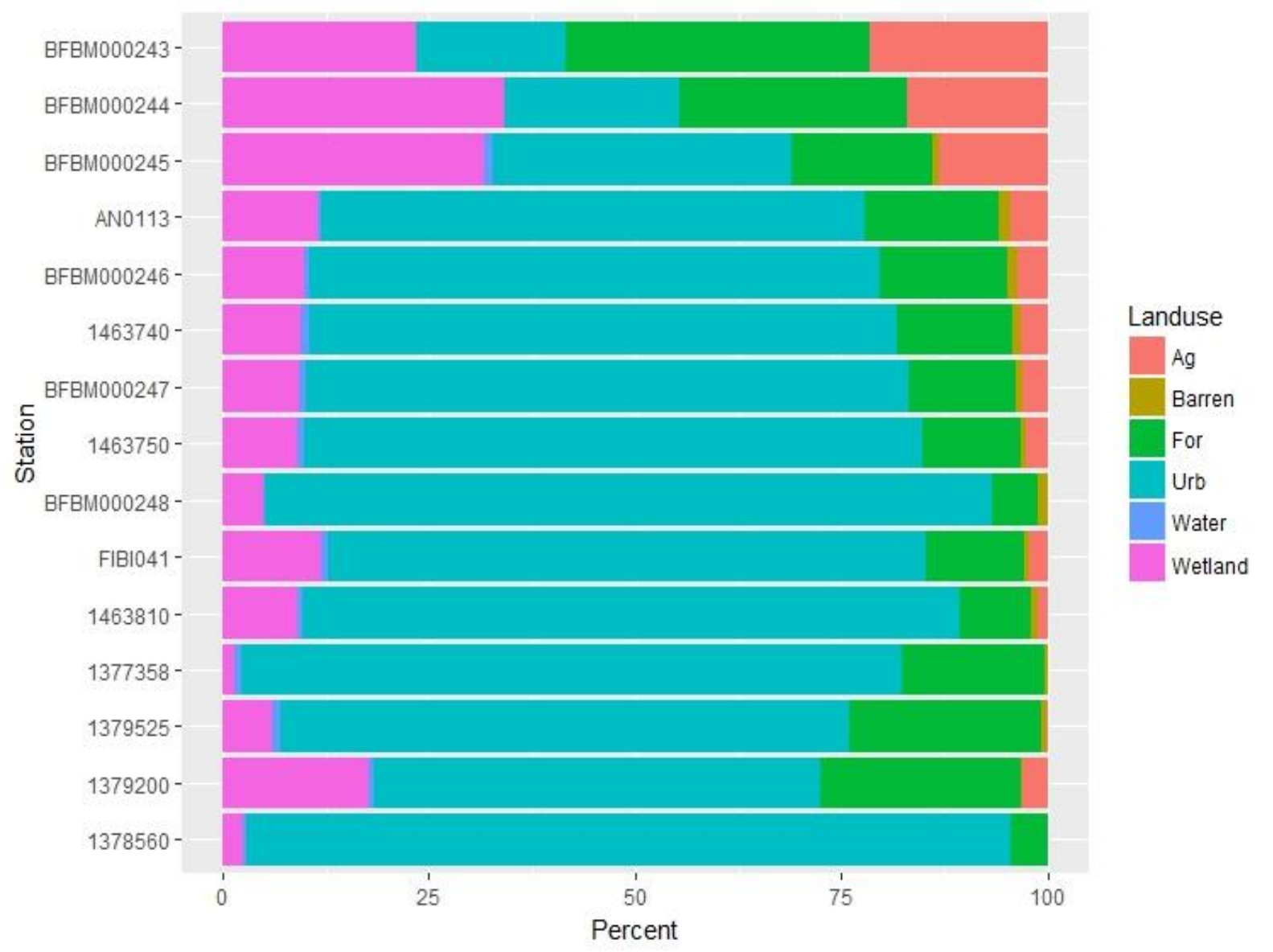
- Is Elevated Specific Conductance/ TDS/Chloride Related To Land Use?
- Is Elevated Specific Conductance/ TDS/Chloride Related To Overall Area Of Impervious Surface?
- Is Elevated Specific Conductance/ TDS/Chloride Related To Overall Length and Type of Roadway?
- Discrete and Continuous Data Utilized.

In-Depth Watershed Evaluation

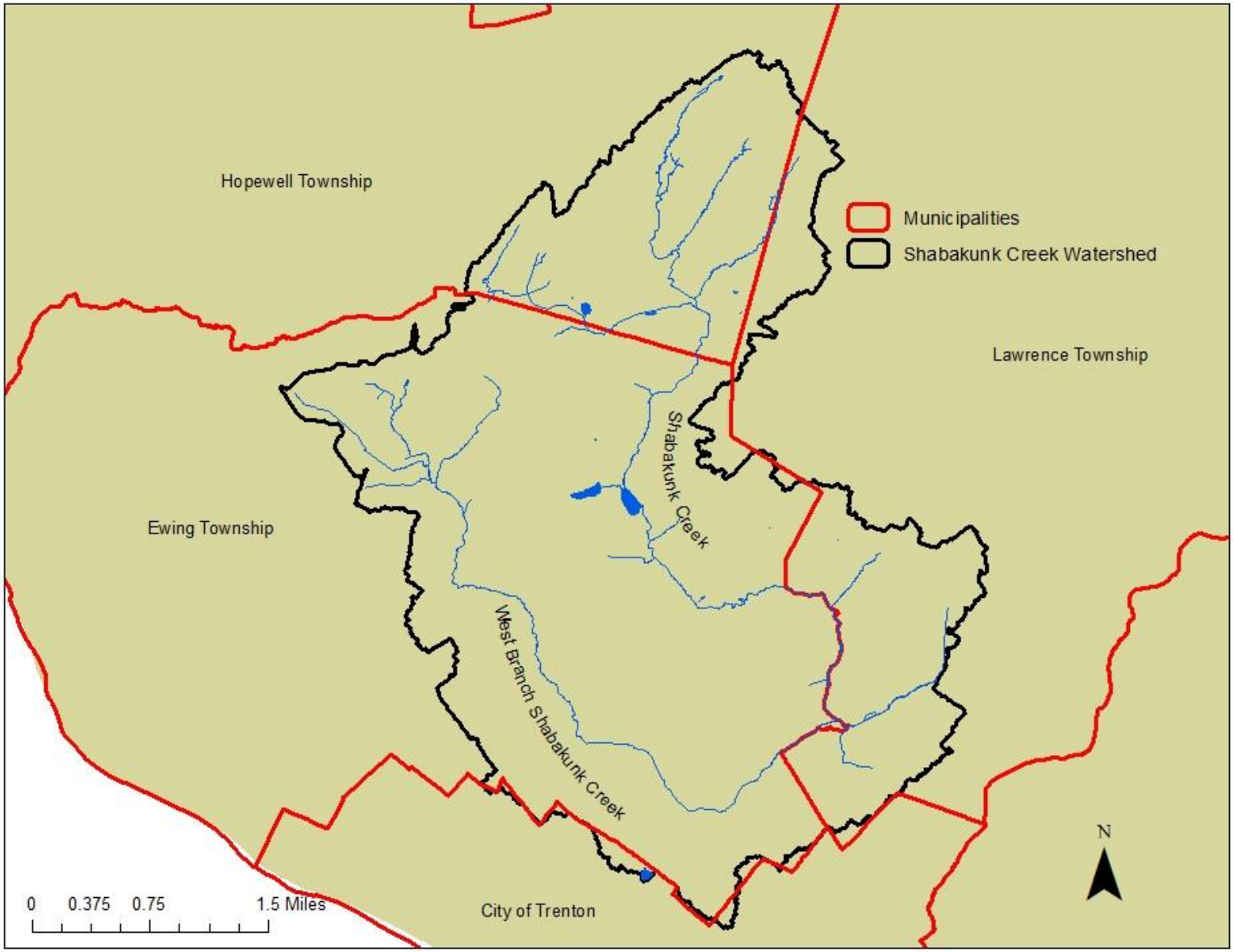
- 15 subwatersheds selected; 11 part of Shabakunk Creek watershed and 4 other watersheds where there are suspected TDS impairments (Pascack Brook, Coles Brook, Canoe Brook and Dead River).
- Shabakunk Creek was selected because of few large incoming tributaries, and land use was fairly uniform. Changes were mainly in terms of overall area.

Watersheds Selected For In-Depth Road Salt Analysis; 2016-2017

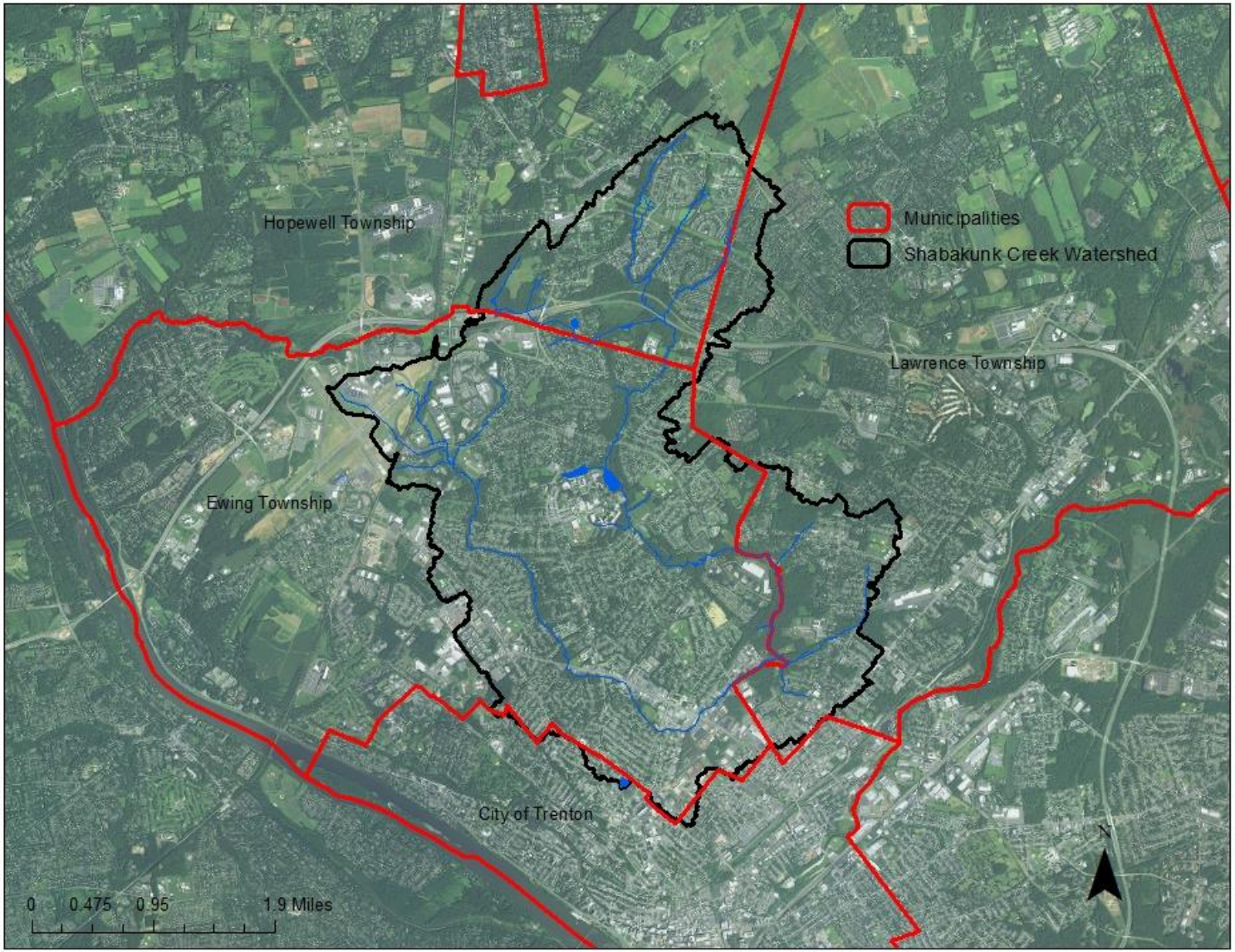



BFBM000243
BFBM000244
BFBM000245
AN0113
BFBM000246
1463740
BFBM000247
1463750
BFBM000248
FIBI041
1463810
1377358
1379525
1379200
1378560
Station
0
25
50
75
100
Percent
Landuse
Ag
Barren
For
Urb
Water
Wetland

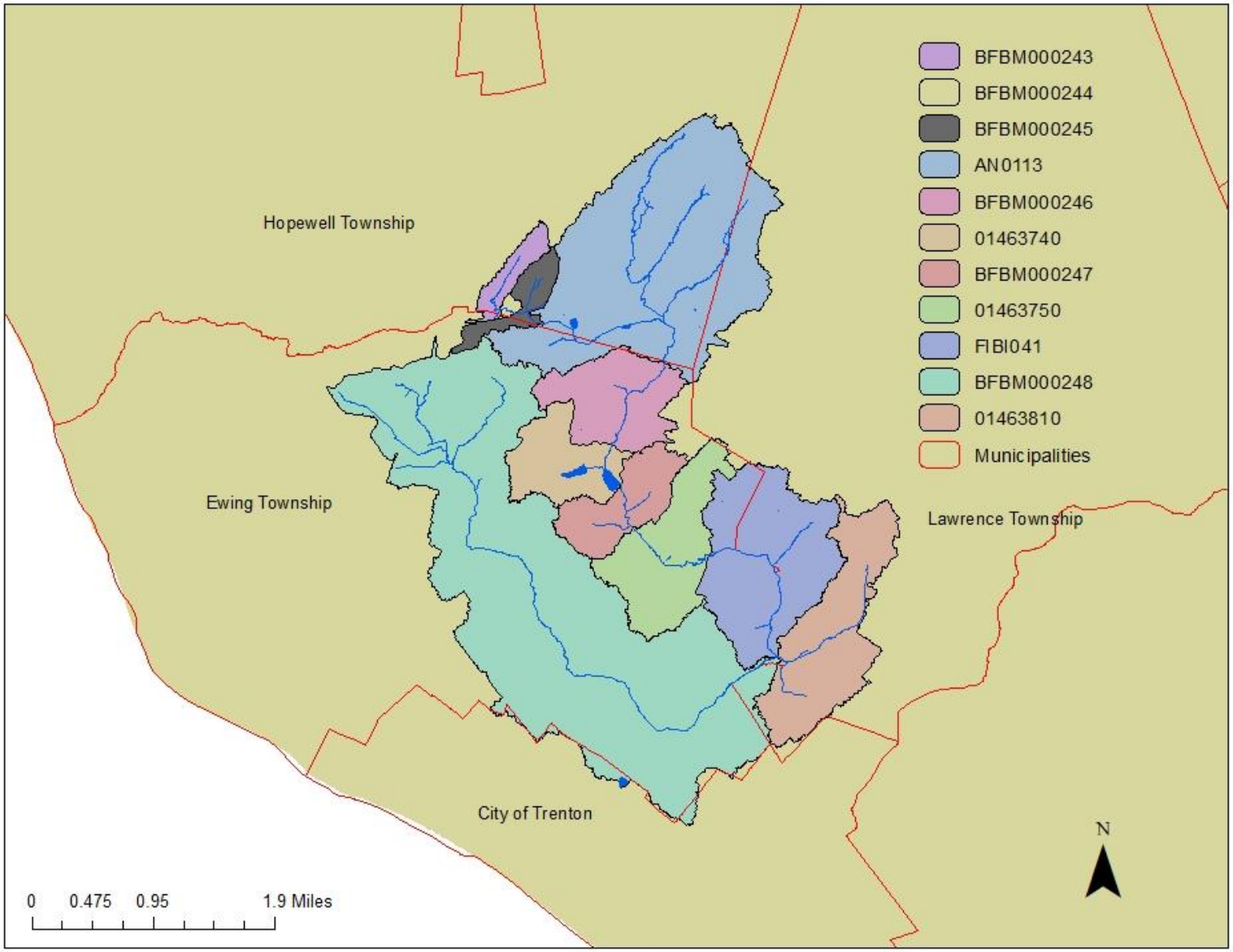
Shabakunk Creek Water Bodies



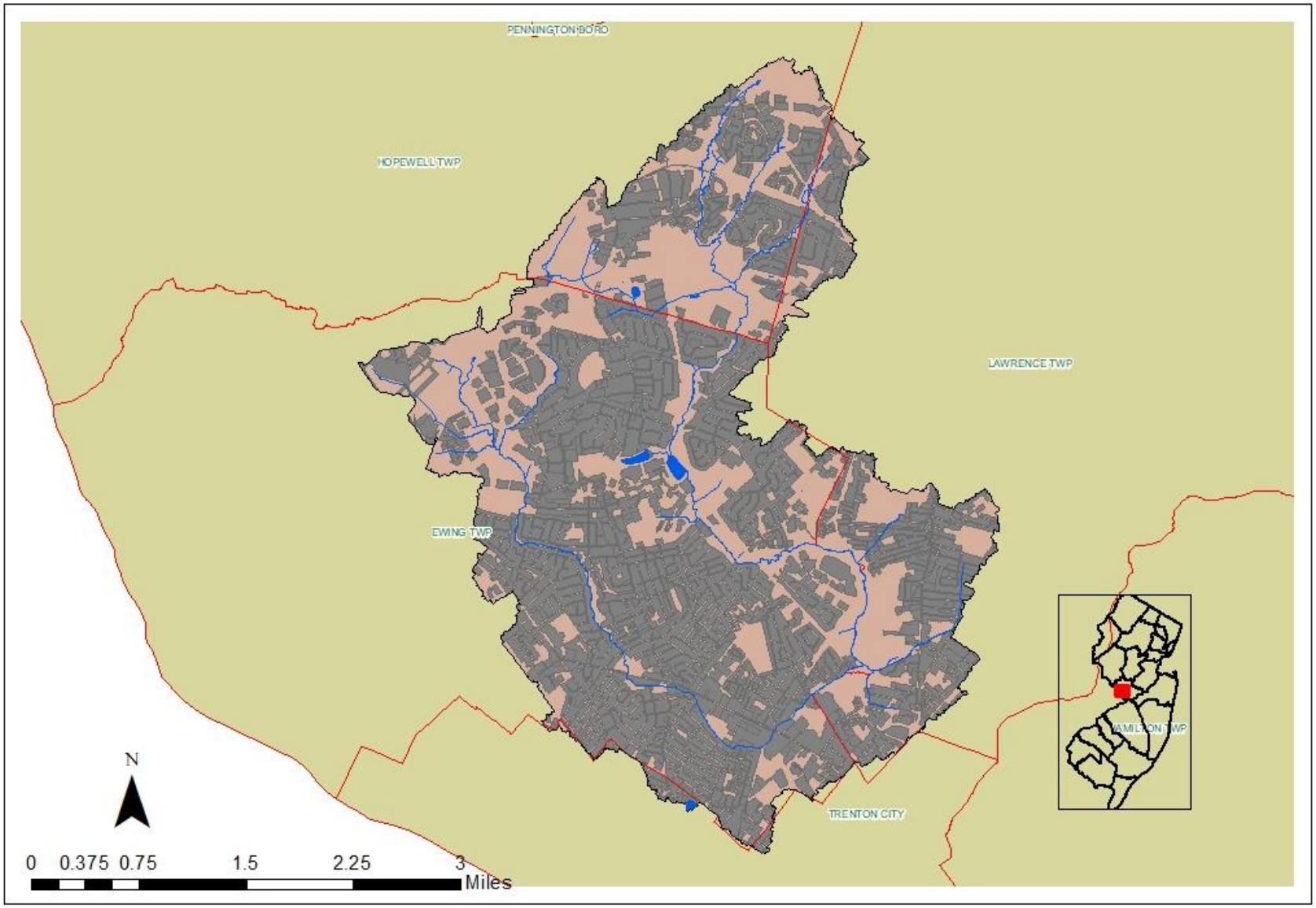
Shabakunk Creek Watershed (2017 Aerial Imagery)



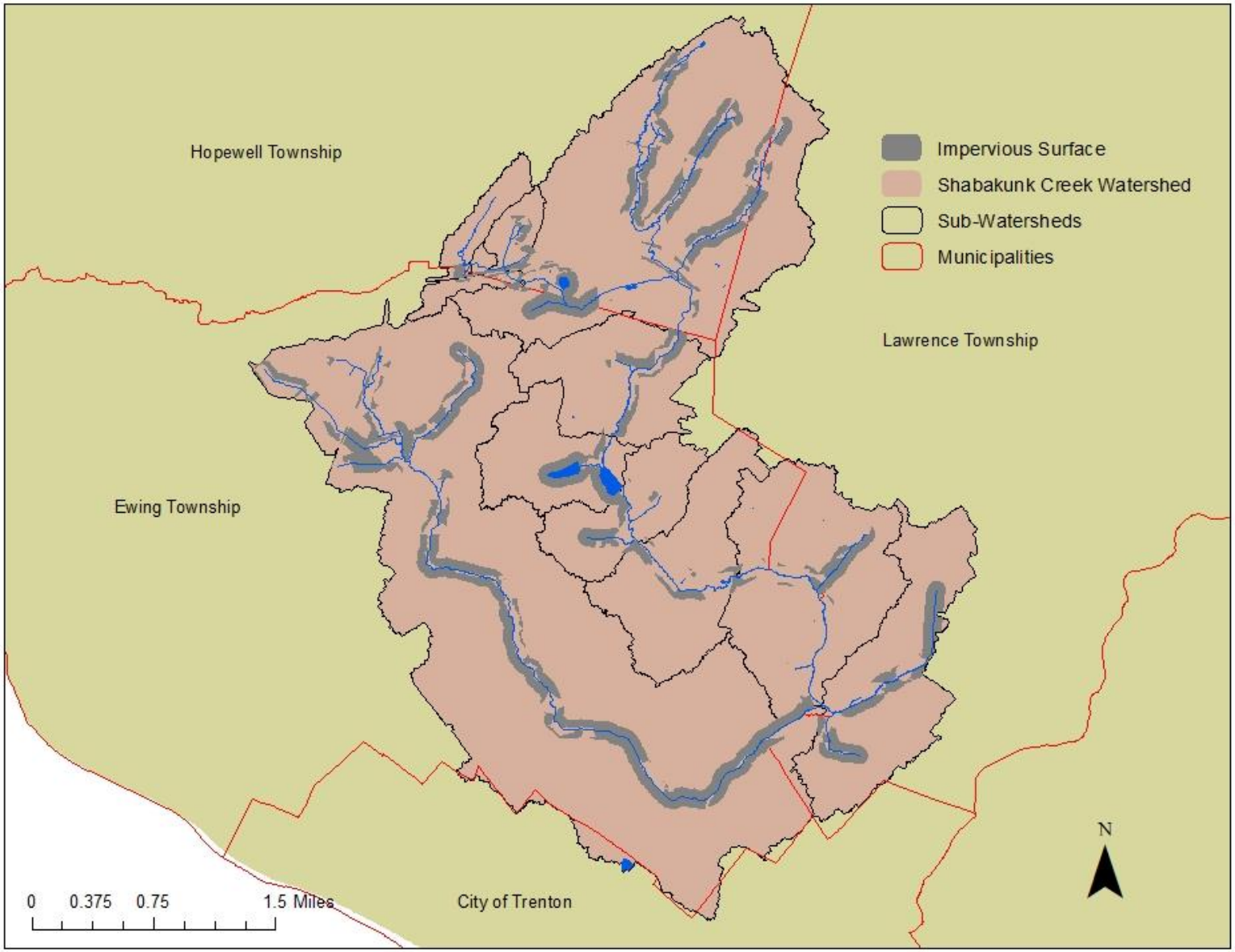
Shabakunk Creek Sub-Watersheds



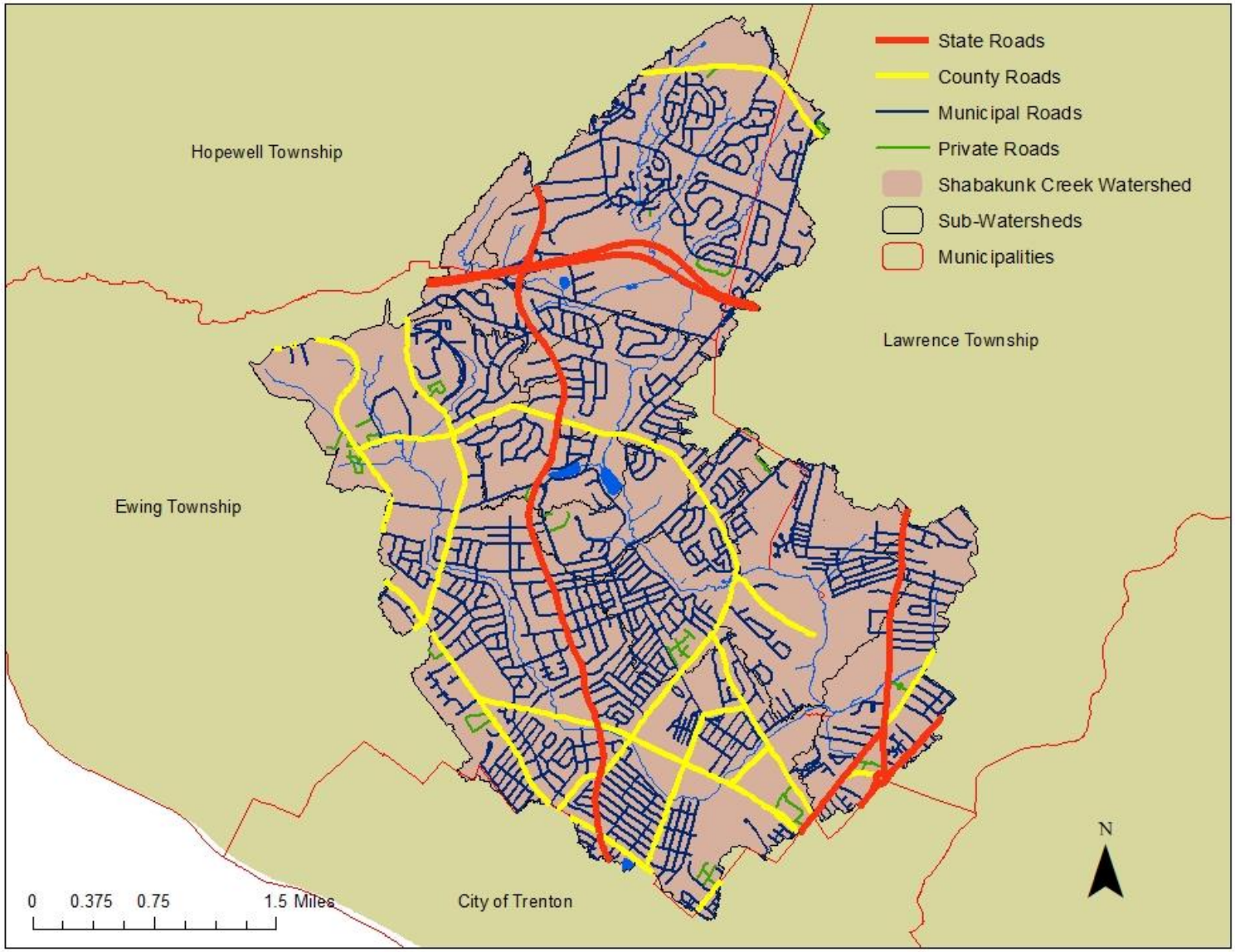
Impervious Surface In The Shabakunk Creek Watershed

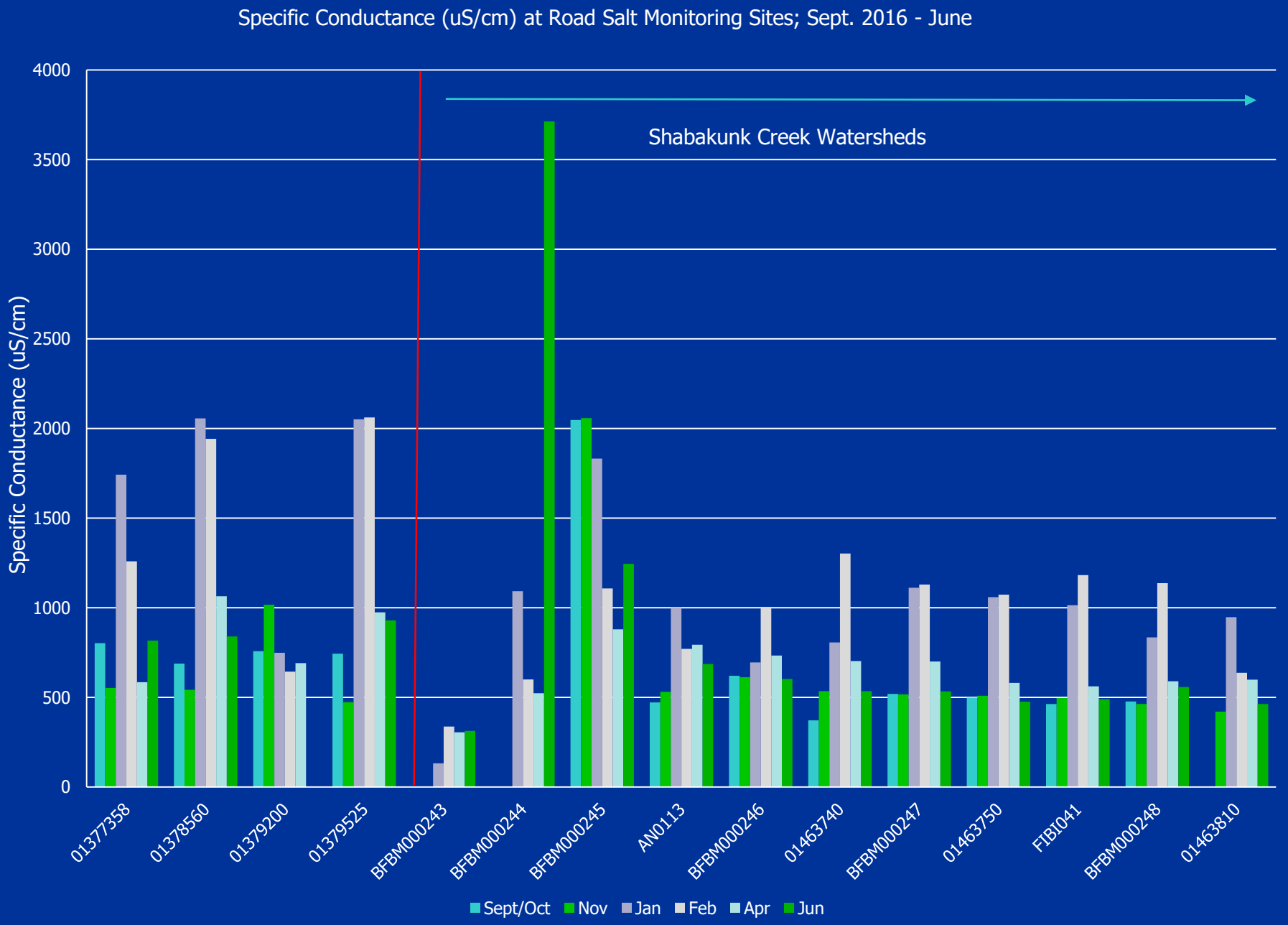


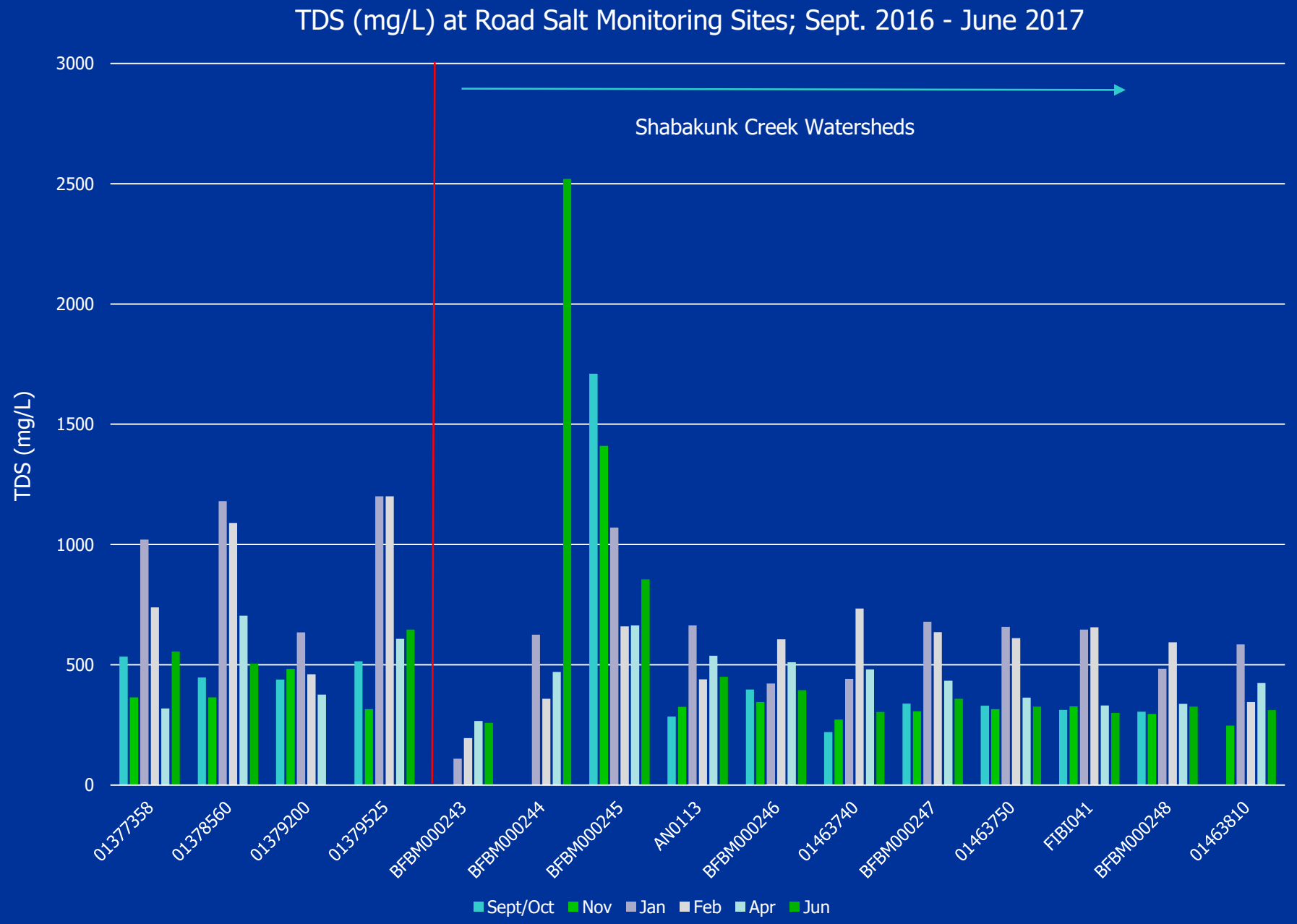
Impervious Surface (300 foot buffer) In The Shabakunk Creek Watershed

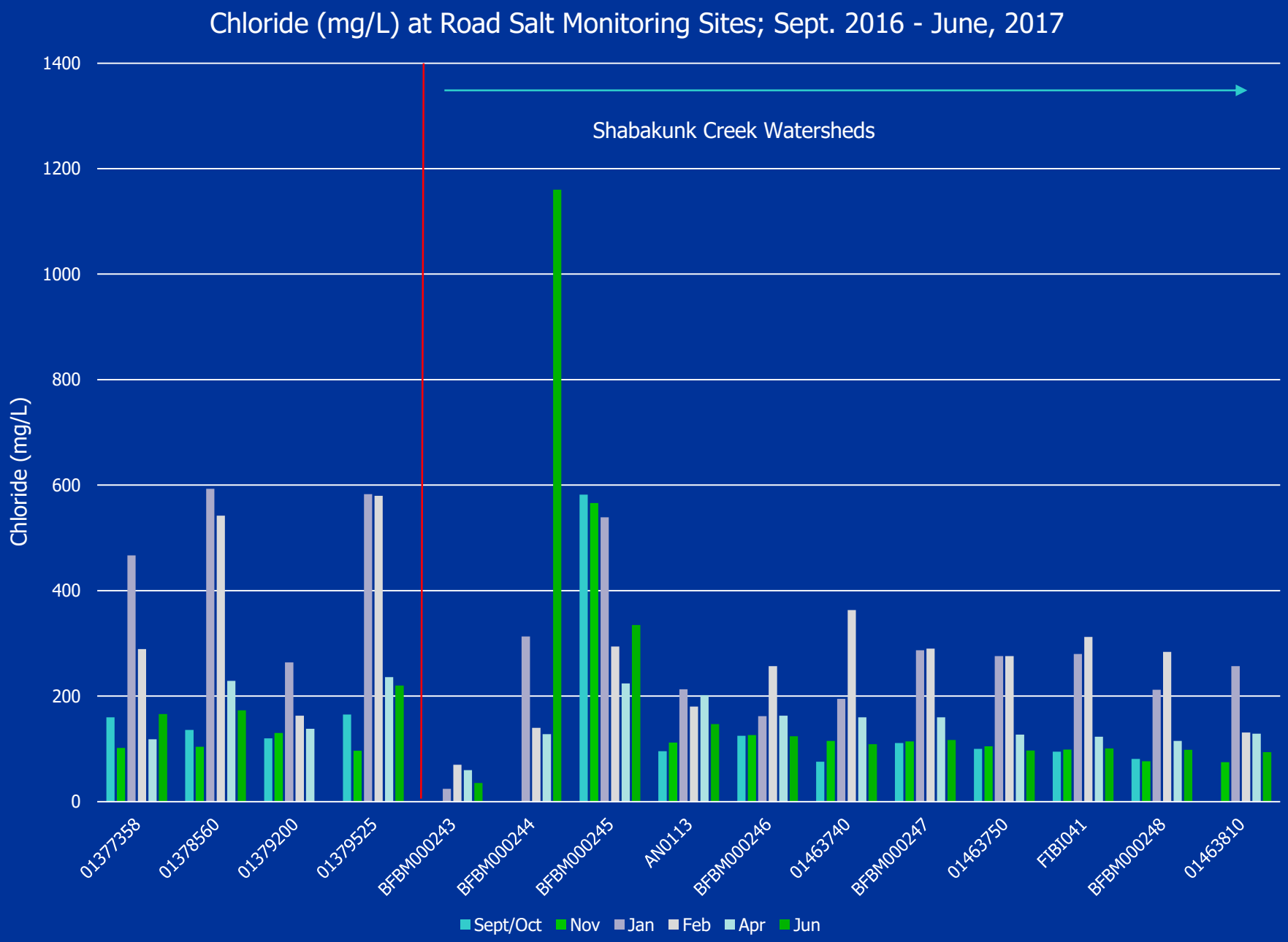


Roadway Types In The Shabakunk Creek Watershed




Specific Conductance (uS/cm) at Road Salt Monitoring Sites; Sept. 2016 - June
Shabakunk Creek Watersheds
Specific Conductance (uS/cm)
4000
3500
3000
2500
2000
1500
1000
500
0
01377358
01378560
01379200
01379525
BFBM000243
BFBM000244
BFBM000245
AN0113
BFBM000246
01463740
BFBM000247
01463750
FIBI041
BFBM000248
01463810
Sept/Oct
Nov
Jan
Feb
Apr
Jun


TDS (mg/L) at Road Salt Monitoring Sites; Sept. 2016 - June 2017
Shabakunk Creek Watersheds
TDS (mg/L)
3000
2500
2000
1500
1000
500
0
01377358
01378560
01379200
01379525
BFBM000243
BFBM000244
BFBM000245
AN0113
BFBM000246
01463740
BFBM000247
01463750
FIBI041
BFBM000248
01463810
Sept/Oct
Nov
Jan
Feb
Apr
Jun


Chloride (mg/L) at Road Salt Monitoring Sites; Sept. 2016 - June, 2017
Shabakunk Creek Watersheds
Chloride (mg/L)
1400
1200
1000
800
600
400
200
0
01377358
01378560
01379200
01379525
BFBM000243
BFBM000244
BFBM000245
AN0113
BFBM000246
01463740
BFBM000247
01463750
FIBI041
BFBM000248
01463810
Sept/Oct
Nov
Jan
Feb
Apr
Jun

Correlation Analysis

- 9 watersheds used.
- Some watersheds not included because of various factors (i.e. watershed not entirely in NJ, data revealed possible point source).
- Spearman's Rank Correlation Analysis between various land use and watershed features and discrete and continuous data.

Land Use and Watershed Features Used For Analysis

% AGRICULTURE
% BARREN LAND
% FOREST
% URBAN
% WATER
% WETLANDS
Overall Area (acres)
Impervious surface (acres)
Impervious Surface (%)
Overall Area (acres) of 300-foot buffer
Impervious surface (acres) 300-foot buffer
Impervious Surface (%) 300-foot buffer
COMMERCIAL SERVICES (acres)
OTHER URBAN OR BUILT UP LAND (acres)
RESIDENTIAL RURAL SINGLE UNIT (acres)
RESIDENTIAL SINGLE UNIT LOW DENSITY (acres)
RESIDENTIAL SINGLE UNIT MEDIUM DENSITY (acres)
TRANSPORTATION COMMUNICATION UTILITIES (acres)
Roads total (miles)
Municipal roads (miles)
County roads (miles)
Private roads (miles)
State roads (miles)

Correlation Analysis Results

r-values and direction (+,-) shown for significant p≤0.05 (unless otherwise indicated) relationships

Discrete Data

	Sept./Oct.			Nov			Jan*			Feb			Apr			Jun			Median*		
	Sp. Cond.	TDS	Chloride	Sp. Cond.	TDS	Chloride	Sp. Cond.	TDS	Chloride	Sp. Cond.	TDS	Chloride	Sp. Cond.	TDS	Chloride	Sp. Cond.	TDS	Chloride	Sp. Cond.	TDS	Chloride
% Water							0.6 (+)	0.62 (+)	0.63 (+)												
% Agriculture										0.7 (-)											
% Wetlands										0.65 (-)			0.65 (-)								
% Barren Land		0.71 (-)																			
Impervious Surfaces (acres)	0.69 (+)	0.69 (+)																			
Overall Area (acres) 300 foot buffer	0.71 (+)	0.83 (+)	0.71 (+)				0.6 (+)		0.62 (+)										0.62 (+)	0.63 (+)	
Impervious surface (acres) 300 foot buffer		0.69 (+)																			
Impervious Surface % 300 foot buffer													0.62 (+)								
Other Urban or Built Up Land (acres)				0.79 (-)																	
Roads-total (miles)		0.76 (+)					0.6 (+)		0.63 (+)										0.61 (+)	0.58 (+)	
Municipal roads (miles)		0.76 (+)							0.62 (+)												

* All p values: 0.05>0.1

Correlation Analysis Results

r-values and direction (+,-) shown for significant p≤0.05 (unless otherwise indicated) relationships

Continuous Data

	Max Values	Median Values	Winter Median Values*
% Water			
% Agriculture			
% Wetlands	0.78 (-)		
% Barren Land			
Impervious Surfaces (acres)			
Overall Area (acres) 300 foot buffer		0.65 (+)	0.6 (+)
Impervious surface (acres) 300 foot buffer			
Impervious Surface % 300 foot buffer	0.87 (+)		
Other Urban or Built Up Land (acres)			
Roads-total (miles)		0.7 (+)	0.63 (+)
Municipal roads (miles)		0.67 (+)	0.58 (+)

* All p values: 0.05>0.1

Informal Road Salt Application Survey

- State DOT information available on website
- 4 counties contacted or information obtained from websites
- 29 municipalities contacted

Agency	Miles of Road Responsibility	Tons of Salt Used/Year	Gallons Liquid Calcium Chloride Used/Year	Gallons Brine Used/Year	Tons of Salt Applied/Mile/Year	Gallons Liquid Calcium Chloride Applied/Mile/Year	Gallons Brine Applied/Mile/Year
NJ State DOT	13341	233042	535241	1638599	17.5	40.1	122.8
County 1	425	6000	0	0	14.1	0.0	0.0
County 2	450	?	?	?	?	?	?
County 3	450	?	?	?	?	?	?
County 4	750	30000	15000	0	40.0	20.0	0.0
Municpality 1	110	300	0	0	2.7	0.0	0.0
Municpality 2	?	2550	0	15300	?	?	?
Municpality 3	?	1500	0	0	?	?	?
Municpality 4	80	1113	1520	5425	13.9	19.0	67.8
Municpality 5	?	985	400	0	?	?	?
Municpality 6	?	1871	0	12000	?	?	?
Municpality 7	?	1200	0	0	?	?	?
Municpality 8	?	2380	6182	0	?	?	?
Municpality 9	?	700	0	3000	?	?	?
Municpality 10	?	550	0	3000	?	?	?
Municpality 11	?	400	700	0	?	?	?

What Now?

- Continued monitoring of watersheds with known or suspected TDS impairments.
- BFBM and BEARS have formed internal NJDEP workgroup to coordinate monitoring, assessment and planning.
- More analysis to be done on previous data collected and future data.

Acknowledgements

- Katherine Axt (NJDEP-BFBM): Project Officer
- Jenna Krug (NJDEP-BFBM): Specific Conductance/Chloride and TDS Relationships, Correlation Analysis
- Leigh Lager (NJDEP-BFBM): Watershed Delineation and Land Use Calculations
- Kelly Krolik (NJDEP-BFBM): Predicted Chloride and TDS Calculations
- Alison McCarthy (formerly NJDEP-BFBM and USGS; now with Clean Ocean Action): Additional GIS Analysis and Calculations
- Erin Dunne (former NJDEP-BFBM intern; now with TerraCycle): Background Research

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